SOME UNUSUAL SOLUTIONS FOR EUROPEAN NETWORKS

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Abstract.

The authors present several non-conventional solutions unused in Europe which are, however, frequently adopted in some medium (M) and low (L) voltages (V) networks from North - American and Australian countries, especially in low density areas of consumption in rural and urban distribution. The proposed solutions may assure diversified supply possibilities in our middle and South –Eastern regions, as regards modernizing and upgrading the distribution networks.The solutions try to propose to adapt our Europeean practice to the North-American experience, aiming to developing more flexible, cheaper and safer supply of the consumers, both at MV and at LV networks. Several original solutions promoted in Romanian networks and their peculiarities are also described.The paper presents distribution schemes at medium voltage in connection with low voltage supply in different condition of neutral treatement at MV or LV. It also shows the measures to be adopted in order to diminish the overvoltages produced in low voltage at the suplied consumers. The tehnical condition of co-existence of OHEL at MV and LV on the same poles, without jeopardizing the LV equipment, are also dealt with.Among the solutions proposed,the authors also describe the unconventional one, consisting in the supply of isolated monophase consumer at MV by ground return and also the conditions necessary for sure and safe operation of this particulary connection .Finaly, there are shown some conclusions about the necesity to assure imposed environmental conditions .

Key words: Consumers supply,small transformers,schemas, safety operation.

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1. Medium Voltage Solutions

Electricity supply of consumers, under safety and economic conditions, is one of the major concerns of electricity suppliers. The solutions adopted to supply various types of users should comply with their installed capacity, the distance from the supply point, required safety level, possibility to recover the expenses for the delivered electricity, etc.
The accomplishment of monophase small-power (MV/0.23 kV) oil or dry transformers, with competitive technical characteristics has enabled finding out specific solutions to supply small installed capacity users, concentrated or dispersed in urban or rural areas. The solutions developed on the basis of new transformer types represent a new stage of several studies and achievements on high voltage use (1000/230 V) in order to supply small users, while diminishing the active losses in the electric supply power grid.
The solutions of bi/three phase transformers begin to be ever more considered when supplying rural consumers living in areas across which a MV electric line is passing, leading to important advantages on reduction losses in distribution network, by eliminating the low voltage network. As for the dispersed users or those grouped in small communities, the solutions with oil-insulated mono/ bi phased transformers, can offer advantageous technical-economic conditions as compared to the present ones. Locating the mono/bi-phase transformers close to the load weight center ensures loss reduction in the low voltage network, cutting down investment in the medium voltage network and providing advantageous economic parameters of the supply. In many cases, medium voltage accomplishment is possible with only one conductor (phase), leading to a substantial

reduction (with 66%) of the investment in line conductors and, practically with 50% of the investment in line.
Depending on the neutral grounding of the medium voltage lines, various solutions can be adopted for the supply of rural localities nearby those lines.

2. Connection diagrams of monophase transformers

The following solutions can be considered:
-three-phase medium voltage line, passing nearby a low power consumer who has to be supplied with electricity
- three-phase line passing nearby some small power consumers who need a three-phase voltage
- small power consumer located at a relatively small distance from the three-phase medium voltage electric line which requires a single-phase supply
- small power consumer located at a relatively small distance from the three-phase medium voltage consumer requiring a three-phase supply
-load symetrization in the medium voltage network by the distributed supply of the consumers groups (low voltage distributed network).Are possible the following variants for supply the consumers which need electrical energy:a)MV lines in a resistor grounded network,passing close or not far to small users; b)The same case but in an network by Petersen coil treated neutral.In the case of resistor grounded neutral,is necessary the analise of the return circuit in normal or desequilbred permanent regime.Is possible to consider the variant with phisical conductor or by ground return,if those few amperes of ground circuit currents remain compatibles with neighbouring installations or equipments.Final solution will adopted upon a calculus of the desequilibre creeated by monophase load,but upon authors opinion in south-east conditions is preferable to adopt the first variant with phisical return conductor,to avoiding EMC complications.

In the case of monophasic consumers,close or not so far from MV line is recommanded to assure the balance of the phase load at MV network by users groups distributed connexion for load simetrisation (LV network distributed load)

În the cases of resistor grounded neutral,the user may be connected on like in the schemes presented in fig.1,2,3,4 by a monophase transformer TM 11,5/0,23 kV. The line is completed with one neutral conductor ground connected at the MV substation grounded resistor R and at the place of TM too.

The cost of the return conductor assure the competitivity of these solution even in the case of the low power users situated at relative short distance of MV line. Neutral conductor is designed for one monophased fault at the TM terminal,load current(almost few amperes) impose only a mecanical criteria..

The monophase TM transformer is presented in foto A and B.

For the users who need three phase ,are necessary three transformers,connected at three phases of the line.This mai be initial realised or like an extinxion of those monophased. Fig.2 is a solution for this situation.

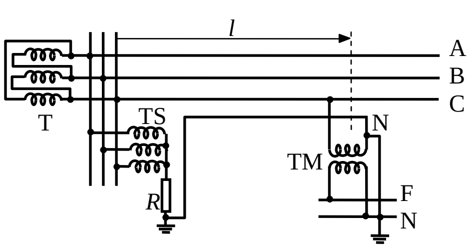

Fig. 1 –The solution for a monophase user close to MV line in a network by resistor neutral

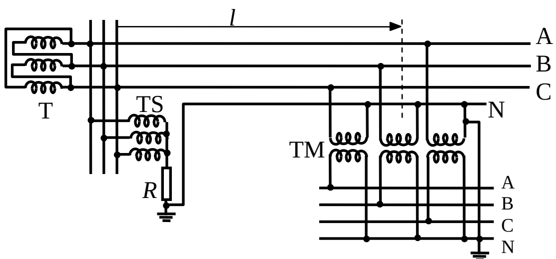

Fig. 2 – Solution for threephase consumer close to MV line in by resistor neutral grounded network.

The neutral point of LV networkis connected to the same earthing like the return conductor of MV network.In the diagram from fig.5 is presented one dispersed LV netvork without the interconnexion posibility of consumers to the same power,that assuring the same load on threephase.This solution corespond to feed a rural locality folowing one river valley,vith consumers to the same load vith.The neutral conductor in permanent regime has the current of desequilibre created by monophased transformers,connected to the MV line(some few amperes,which flow by ground in absence of the return neutral) .

Foto.A Monophase transformer MV/LV

Foto B- Solution for threephaseuser

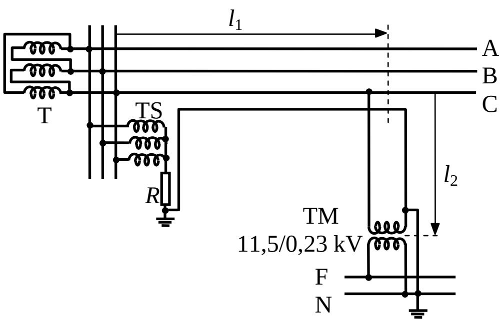

Fig. 3 Solution for one monophase user at small distance from MV line in an neutral by resistor grounded network.

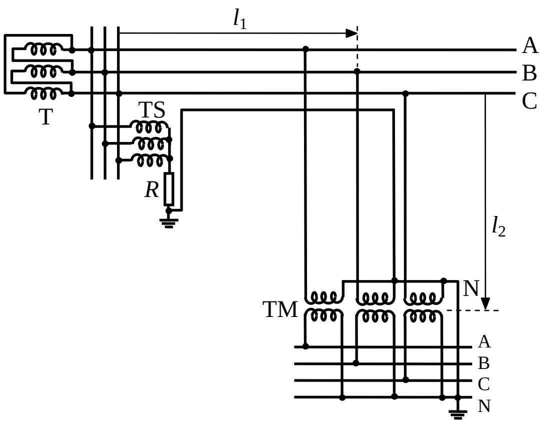

Fig.4 .Solution for three or monophase phase users at the l_2 distance from MV line in a neutral by resistor grounded network

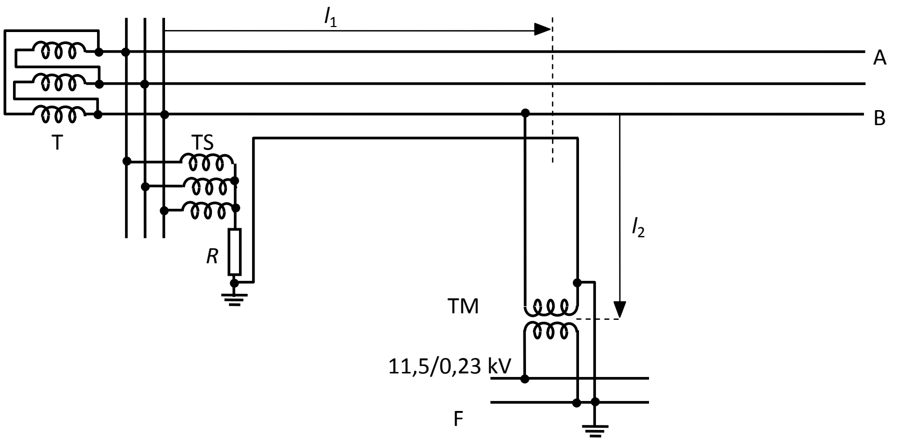

Fig. 5 – Schema de alimentare a unui consumator monofazat situat la distanţa l_2 de o linie de medie tensiune.

3 Connexion schemas with biphase transformers.
These connexion correspond to Peterson coil treated neutral.The connexion is more simple and no need neutral conductor.May be the next variants:

- -monophase user close to the MV line
- -user who need 400 V
- -threephase user
- -dispersed users along th MV line
- -dispersed users situated relative close to the MV line (isolated farm)

In practice may find and other situations where may be used biphase small power transformers to feed some reduced load zones.

4.Technical limits for using small power transformers.
Monophased or biphased loads connected to threephased MV line must be monitorised and designed to not create an asymetry factor exceding admissible limits and significant perturbing the normative values of phase voltages at all the users in normal regime and in an load gap.Proper ineguality of aerian MV line may amplify the nesymmetry of phase currents. In

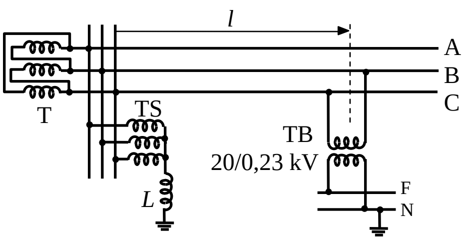

Fig. 6 – Monophase user close a MV line in Petersen coil treated network.

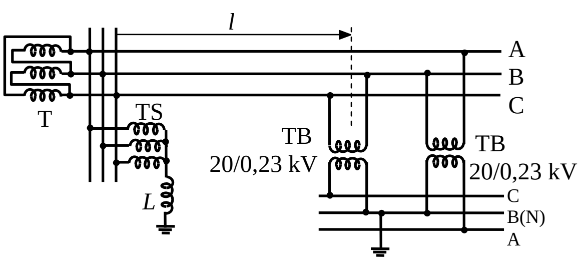

Fig. 7 – Monophase and poliphased users close to a MV line in an Petersen coil treated network.

respect of those is recommanded that before transformers connect need to analise network asymmetry to establish the phase with the greatest voltage due to natural network lack of balance.Mono(bi)phase transformers will be connected at the phases with the greatest voltage,avoiding to amplify the permanent line asymetry.The voltage fall on return circuit must be limited at the imposed values,especially in the case is used the ground return of current.The design of the return conductor impose only mecanical conditions because the small value of the return current.(Table 1)Often is sufficent the ST/AL 25 mmq.Table 1

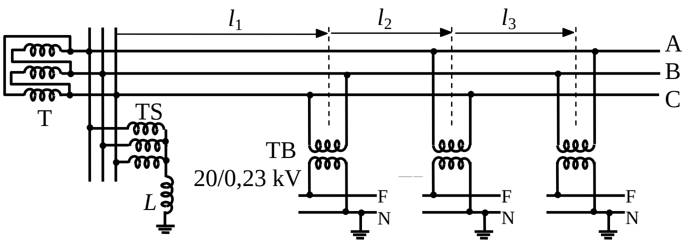

Fig. 8 – Monophased dispersed users close to MV line in Petersen coil treated network

Table 1

Electric current in monophase transformers

Nominal power kVA	Current A
5	0,433
10	0,866
15	1,3
20	1,732
25	2,165
30	2,6
35	3,03
40	3,464

5.Original alternative.

The small power single-phase consumers may be supplied from new regenerable power sources, like the wind, solar or from combustion cell ones.

Such solutions became classical and have promising development perspectives in the industrial countries. In our country, some successful experiments concerning the electric power supply from such sources have been adopted, but the solutions seem not yet acceptable for the village consumers, not so much as concerns the cost price of the power supplied from regenerable sources (15 ¢/kWh from photovoltaic cells, 20 ¢/kWh at the wind supplied central stations) but especially because of the initial prohibitive investment. That is why the authors adopted the local power system supply.

Paper idea is based on the practical need of the supply for Poiana Florilor (PF) single-phase low voltage consumer situated at about 3 km distance from LEA 20 kV connection Aleşd Aştileu Pădurea Neagră,in Bihor county.

The mentioned line is supplied from the Aleşd station (I_{SC}=4,35 kA on bus bars), has the section of 120 mm^2 Al-ST and the from the line is situated at about 5,7 km from Aleşd station and has the section of 35 mm^2 Al-ST and a length of 1 km.

The power required by the consumer situated at 3 km from PT 63 KVA is of 30 kW at cos φ = 0,8.

The area where the consumer is situated in the second zone from meteo point of view, but is considered difficult from white frost layers point of view and frequently endangered from atmospheric discharges.

The network from which the connection is supply has the neutral point grounded with Petersen coil (BS) and network earthing capacitive current for which the ground plate is calculated of 10A.

The route the electric power supply LEA line should follow is parallel to the aces road to the “PF” consumer from reasons related to Romsilva agreement.

Starting from this real problem was treated in a more general context the electrification of single-phase small consumers distributed in areas with low consumption.

The real electrification solution in this case vas selected from following main alternatives:

- Three phase/single phase medium/low voltage line
- Two phase medium (low) voltage line
- Single phase line with current return by the ground

From the constructive point of view, the lines can be achieved on concrete or wood poles with ordinary or insulated wires, in simple suspended or twisted system.

The performed analysis excluded the alternative with underground cable supply, which is by far not competitive.

From the comparative analysis following data supplied by S.C. ELECTRICA related to the specific costs of the three-phase aerial lines of the different types and compositions was chosen the solution with single phase and ground return current,at 6 kV rate.The arguments and tehnical conditions for this selection were largely presented in [1]

The schema and parameters for calculation is presented in fig.9 and the diagram for PT1 and PT2 at the beginning and the terminal point of this racord in the fig.10.

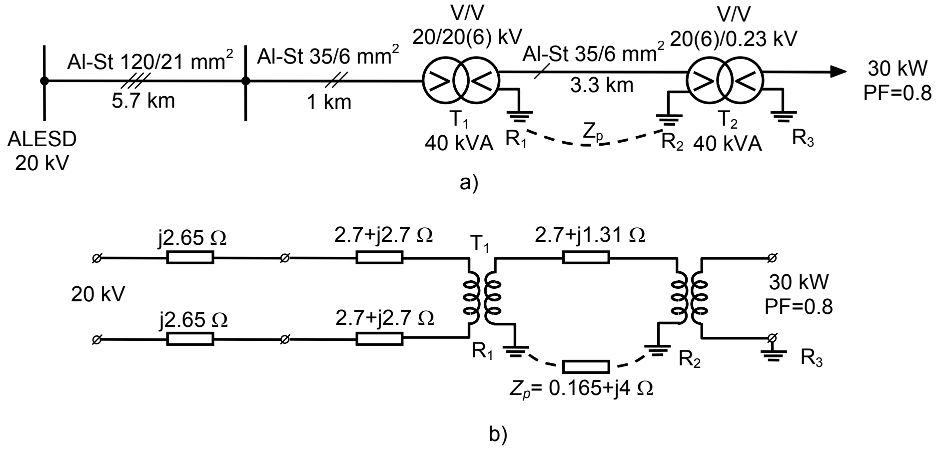

Figure 9 – Circuit diagram (a) and parameters for calculation:
T_1; T_2 : 220+j290 Ω (20 kV); 18+26 Ω (6 kV) ; R_1; R_2 :20 Ω at 20 kV; 7.5 Ω at 6 kV;
Shortcircuit impedance of T_1 and T_2 are divided in two equal parts.

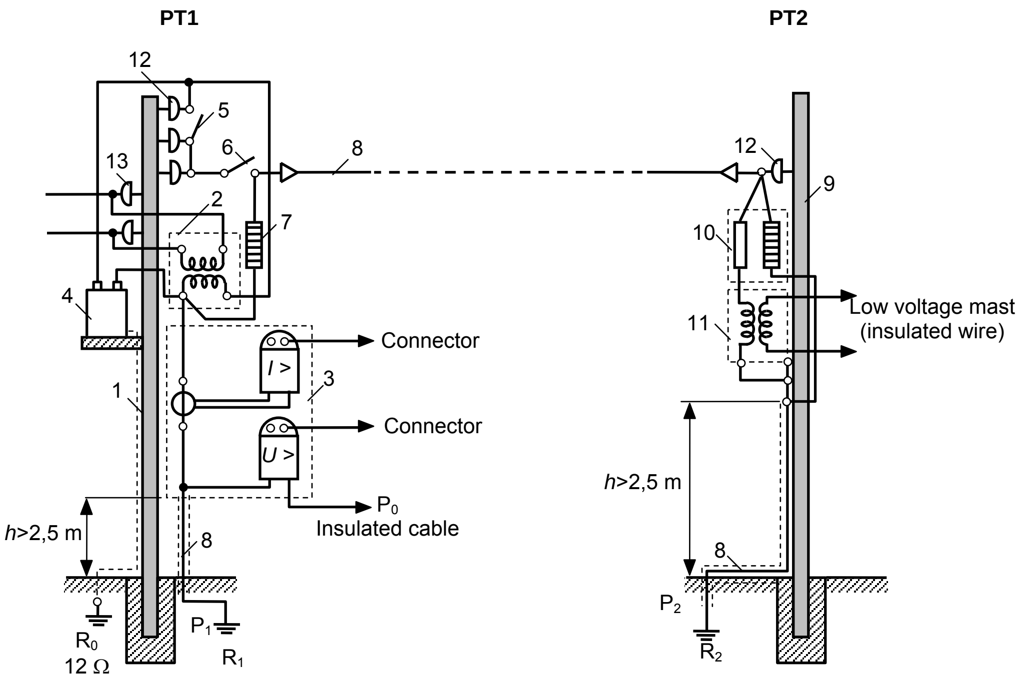

Figure 10 − Circuit diagram for PT1 and PT2 a 20(6) kV:
1− Wood pole (H type or in concrete foundation; 2 –Transformer 20/20(6) kV, 40 kVA – TMD; 3 − Polycarbonate cabinet with current transformer, relays and d.c. battery; 4− Voltage transformer 20(6)/0,1 kV; 5− Single phase connector 24 kV in vacuum; 6 − Single phase Ampact disconnector (ELCO); 7 − Ozn discharger (surge arrester); 8 − Al-St wire 50 mm^2 insulated; 9− Wood terminal pole (H type or in concrete foundation); 10 − Fuse frame 24 kV and single phase discharger SSFED (ELCO); 11 − Single phase transformer 20(6)/0.23 kV 40 kVA TMD; 12 − Insulator 24 kV; 13 − Insulator 24 kV; P_1, P_2 − Earthing 20 Ω; R_0 − Earthing 12 Ω.

Conclusions

The use of the monophase or biphase low power transformers (max 100 Kva) may represent a very smart solution who lead to important investitional economy in network and in electrical losses.The conductors and isolation costs are reduced with 2/3 and the poles may be more simply and light.

The technical limits results from the accepted network nessymetry factor and from the permanent return current,especially in the case of using the ground in this purpose

To achieve an electrification of some isolated single phase low power consumers was possible tu adopt the solution with single MV phase with ground return.For this purpose was adopted an isolation transformer from the 3F-MT network and create an isolated network who has grounded neutral.

The connexions to earting of the transformers at the both ends of the monophasic racord was realised with very good isolated wires,to prevent touch and step voltages in normal and isolation defection.The condition of design for the earthing of both transformers are very special.

References

[1] COROIU N., GOIA M. L., *UNCONVENTIONAL SOLUTION FOR LOW POWER SINGLE-PHASE CONSUMER SUPPLY*, CIRED Torino, 2005, 0389

[2] de la Rosa F., Mak S. T., *A Look into Steady State and Transient Performance of Power Lines Integrating Single Wire Earth Return Circuits*, PESGM 2007, Tampa, Florida, Rap.000471

[3] VILLOT A.V., ZAPATA A. H., GURUMETA E. M.,*ENVIRONMENTAL TRANSFORMER SUBSTA-TION* , CIRED Torino, 2005, 0103

[4]Wolfs P.J., Hosseinzadeh N., Senini S.T., *Capacity Enhancement for Aging Distribution Systems using Single Wire Earth Return*, PESGM 2007, Tampa, Florida, Rap.000388